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June 1981

NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide: Version II

by Timothy M. Gelpe

U.S. Army Electronics Research
and Development Command
Harry Diamond Laboratories
Adelphi, MD 20783

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This report serves as a second version to the Nuclear Damage Assessment Computer Code (NUDACC) Programmer's Guide (HDL-SR-80-1). The initial report served as a user's manual for the analyst or the programmer interested in installing and using NUDACC. As such, the initial report contained a description of NUDACC methodology as well as detailed descriptions of file structure, mass storage requirements, and logic flow. Recent major improvements in the computer code have involved the handling of the input vulnerability data. These improvements significantly affect the logic of the computer code described in the initial report, thus creating the need for the up-to-date user's manual represented by this report.

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FOREWORD

The first version of the Nuclear Damage Assessment Computer Code (NUDACC) Programmer's Guide (by Ralph G. Moore, Harry Diamond Laboratories HDL-SR-80-1, August 1980) served primarily the analyst or the programmer interested in installing and using NUDACC. This second version of the Programmer's Guide reflects major improvements in NUDACC for handling input vulnerability data. These improvements significantly affect the logic of the computer code described in HDL-SR-80-1.

When the computer code was conceived, it was thought that the vulnerability data for equipment items would not change. These data were made organic to the computer code by using DATA statements in the FORTRAN code. Due to the repetition of data, storage space was minimized by storing only unique data and creating arrays that "point" to the actual data.

The vulnerability data do change, though, making changes to the code necessary as the data change. This was a complex procedure since it was necessary to modify several arrays for a single change. For this reason, the vulnerability data were placed in a sequential disk data set where changing the data was a less complex task and would not involve changing the code.

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1. INTRODUCTION

This report is a revised version of NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide.[1] Major changes to the computer code involving the handling of vulnerability data resulted in the need for this up-to-date user's manual.

The Nuclear Damage Assessment Computer Code (NUDACC)[2] described in this report is an outgrowth of a requirement of the U.S. Army's Theater Nuclear Force Survivability Program to provide accurate assessment of the survival of blue theater nuclear forces after a USSR-Warsaw Pact (red) nuclear attack. Assessments of this nature have often been made by using a cookie-cutter methodology. A circle of appropriate radius is drawn around the actual ground zero (AGZ), and items within the circle are considered killed.

A moment's reflection on this approach will confirm that although the simplicity of method is attractive, it is certainly not realistic.

The NUDACC methodology determines a probability of survival for personnel and equipment based on a cumulative log-normal function of a particular nuclear weapons effects (NWE) environment. Many equipment items are vulnerable to several NWE environments, in which case the individual probabilities are multiplied to determine the probability of survival of the item.

To simplify further discussion, it is necessary to define the following terms:

Term	Definition
UNIT	Any combination of personnel and equipment that constitutes a logical functional entity and can be contained in a rectangular area as small as 50 m on a side or as large as 500 m on a side (This size restriction is due to the current data dimensions of the program and can easily be modified.)
UNIT NAME	Name assigned to unit
UNIT IDENTIFICATION NUMBER	Unique seven-digit integer number assigned to each unit (This number is used to correlate corresponding data in several files.)
UNIT LENGTH, WIDTH	Geometric parameters of unit (in meters): LENGTH = distance from front to rear; WIDTH = distance across front (Each value can range from 50 to 500 m.)
RIGHT REAR CORNER	Corner to right and rear of observer located in center of unit and looking toward front (This corner is used to locate unit.)

[1] *Ralph G. Moore, NUDACC (Nuclear Damage Assessment Computer Code) Programmer's Guide, Harry Diamond Laboratories HDL-SR-80-1 (August 1980).*

[2] *Joseph V. Michalowicz, Ralph G. Moore, and Kenneth W. Sweasy, NUDACC—A Nuclear Damage Assessment Computer Code (U), Harry Diamond Laboratories HDL-PR-78-3 (November 1978). (CONFIDENTIAL)*

Term	Definition
UNIT LOCATION	The x-y location of unit's right rear corner (in meters) (Origin of coordinate system must be chosen so that all x-y values are positive.)
UNIT ROTATION ANGLE	Angle in degrees about right rear corner measured counterclockwise from horizontal
EQUIPMENT MENU	List of personnel and equipment organic to unit
EQUIPMENT CODE	Unique three-digit integer number used to identify item in equipment menu
DOMINANT KILL MECHANISM	Most damaging of several NWE environments affecting an item

DOMINANT KILL MECHANISM CODE

Code	Meaning
0	No NWE vulnerability data on item (or hard)
1	Electromagnetic pulse (EMP) *only*
2	Neutron fluence *only*
3	EMP *and* neutron fluence
4	Peak static overpressure (ΔP) x dynamic pressure impulse (I_q) − threshold for vehicle overturn (K) *only*
5	ΔPI_q − K *and* EMP
6	ΔPI_q − K *and* neutron fluence
7	ΔPI_q − K *and* neutron fluence *and* EMP

2. NUDACC METHODOLOGY

2.1 *Subroutine Flow Chart*

The current version of NUDACC can perform a static (snapshot) evaluation of NWE equipment damage and personnel casualties after a nuclear burst on the battlefield. All units are considered stationary; the weapons are considered in the order in which their parameters are entered as input data. A narrative of the control logic written in structured form and a subroutine flow chart (fig. 1) follow.

- Read in the unit location, size, and orientation.
- Read in the weapon location and yield.
  - Calculate the maximum effects radius.

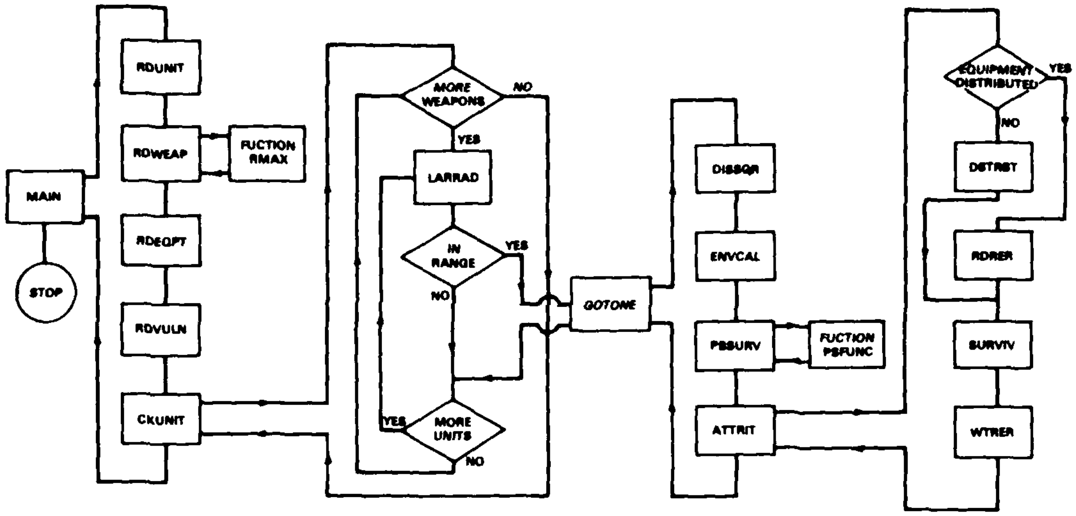

Figure 1. NUDACC subroutine flow chart.

- Read in the equipment for each unit.
- Read in vulnerability data for all equipment items.
- Select and detonate each weapon.

  For each unit,

  - Calculate the distance from the weapon burst point projected on the ground to the unit.
  - If this distance is less than the maximum effects radius of the weapon, process the unit.
    - Divide the unit into grid squares 50 m on a side, and calculate the distance from the weapon to the center of each of these grids (fig. 2).
    - Calculate the various environments at the center of each grid square, and accumulate the dose.
    - Calculate the probability of survival of all items for which data exist as a result of these environments.
    - Calculate the attrition of the items.

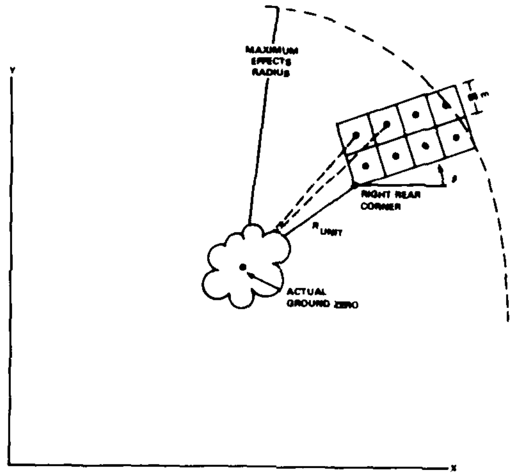

Figure 2. Unit within range.

The attrition of items (personnel and equipment) is calculated in the following manner:

- If the items have not been distributed over the unit, then distribute the items; otherwise, read the surviving items from a random file.
- Multiply the items in each grid square by the appropriate probability of survival to determine the number surviving at that grid.
- Sum each item over the unit to determine the number of that particular item surviving after that particular weapon, and write those items to a file for further processing; then redistribute surviving personnel and equipment according to the computed values for each grid square, and write the distributed equipment to the random file.

The output from NUDACC is passed to a SORT routine, which reorganizes the data for the NUDPRINT program. The output from NUDPRINT is a printout that has an entry for each unit and lists the personnel and the equipment surviving each critical weapon and the dominant kill mechanism for that item. The job execution sequence is illustrated in figure 3.

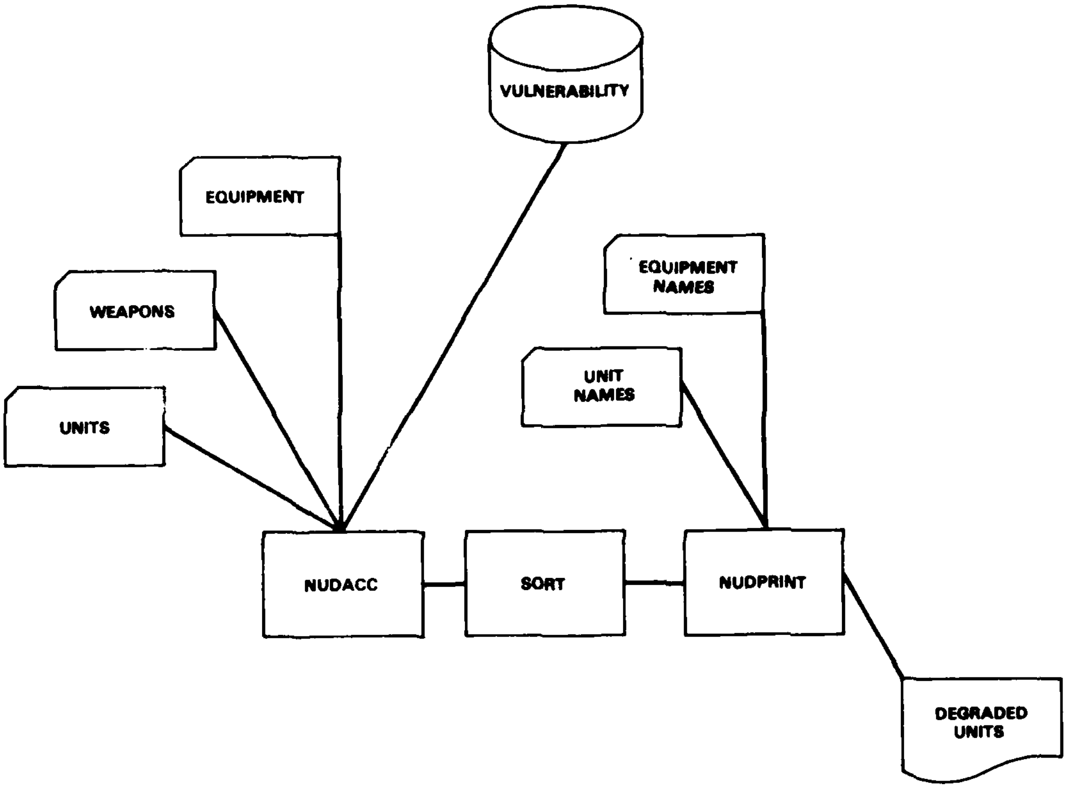

Figure 3. Job execution sequence.

2.2 *Environments*

Sweeney et al[3] comprehensively discuss the environmental equations used in NUDACC. The following environments are calculated:

Radiation (total dose)

Blast (vehicle overturn, $\Delta PI_q - K$)

Transient radiation effects on electronics (TREE) *(neutron fluence)*

EMP (vertical electric field)

---

[3]William E. Sweeney, Jr., Cyrus G. Moazed, and John S. Wicklund, Nuclear Weapons Environments for Vulnerability Assessments to Support Tactical Nuclear Warfare Studies (U), Harry Diamond Laboratories HDL-TM-77-4 (June 1977). (CONFIDENTIAL)

The following damage mechanisms are considered:

a. Personnel (total dose)

(1) Postures considered

(a) Exposed
(b) Open vehicle
(c) Foxhole
(d) Armored personnel carrier
(e) Tank

(2) Damage criteria for each posture

(a) Immediate permanent incapacitation, undemanding tasks (18 krad [tissue])*

(b) Immediate permanent incapacitation, demanding tasks (8 krad [tissue])

(c) Immediate transient incapacitation, undemanding tasks (3 krad [tissue])

(d) Immediate transient incapacitation, demanding tasks (2 krad [tissue])

(e) Latent lethality (0.65 krad [tissue])

b. Vehicles (overturn)—$\Delta PI_q - K$

c. Electronics

(1) Neutron fluence (TREE)
(2) EMP
(3) $\Delta PI_q - K$ (mounted in vehicles)

Any items located within the circle defined by the projection of the fireball on the ground are considered destroyed without further processing.

Equipment is categorized into one of the following nine equipment codes code for input:

100-199	Wheeled vehicles
200-299	Tracked vehicles
300-399	Radios
400-499	Electronic equipment
500-599	Radars and sensors
600-699	Missile systems
700-799	Power generation equipment
800-899	Weapon items
900-999	Aircraft

*Conversion: 100 rad = 1 gray (Gy).

Personnel and their posture may also be specified according to the following code:

001	Exposed
002	Open vehicle
003	Foxhole
004	Amored personnel carrier
005	Tank

The number of personnel or items of equipment is specified by a three-digit count immediately following the category code.

2.3 *Restrictions*

The current data arrays and file structures for both NUDACC and NUDPRINT are limited to maxima of 600 units, 45 equipment codes per unit, and 200 weapons.

3. INPUT FILES

3.1 *General*

The files described below, with the exception of the vulnerability data set, are generated by the user. The vulnerability data are located on disk and may be modified when necessary. Records in all other files are expected to be in card image format.

3.2 *NUDACC Input Files*

Unit data, data set reference No. 5, File 1

Code FORMAT (I7,3X,2F10.0,3F5.0)

Card format:

Column	Description
01-07	Unit identification number
08-10	Unused
11-20	Unit location (x value, meters)
21-30	Unit location (y value, meters)
31-35	Unit rotation angle (degrees)
36-40	Unit length (meters)
41-45	Unit width (meters)
46-80	Unused (or comments)

Weapon data, data set reference No. 5, File 2

Code FORMAT (3F10.0)

Card format:

Column	Description
01-10	Yield (kilotons)
11-20	Weapon location (x value, meters)
21-30	Weapon location (y value, meters)

Unit equipment file, data set reference No. 5, File 3

Code FORMAT (I7,5X,9(2I3,1X))

Card format:

Column	Description
01-07	Unit identification number
08-12	Unused
13-75	9 (equipment code, count, one space)
76-80	Unused

Vulnerability data, data set reference No. 8, File 1

Code FORMAT (I4,I1,7(F10.3),F5.2)

Disk data set format:

Column	Description
01-04	Equipment code
05	Dominant kill mechanism code
06-15	Mean (μ) for EMP environment
16-25	Standard deviation (σ) for EMP environment
26-35	μ for neutron fluence environment
36-45	σ for neutron fluence environment
46-55	μ for $\Delta PI_q - K$ environment
56-65	σ for $\Delta PI_q - K$ environment
66-75	K for $\Delta PI_q - K$ environment
76-80	Transmission factor

3.3 *NUDPRINT Input Files*

Unit name file, data set reference No. 3, File 1

Code FORMAT (I7,9X,16A4)

Card format:

Column	Description
01-07	Unit identification number
08-16	Unused
17-80	Unit name

Equipment name file, data set reference No. 10, File 1

Code FORMAT (I3,2X,12A4)

Card format:

Column	Description
01-03	Equipment code
04-05	Unused
06-53	Equipment name
54-80	Unused

4. MASS STORAGE FILES

Tables 1 to 3 indicate the mass storage requirements of the current version of NUDACC as implemented on the Harry Diamond Laboratories (HDL) IBM System 370 Model 168 computer. The following codes are used:

File type	File status	Number of records
R Random	N New	V Variable
S Sequential	T Temporary	
	P Pass	
	O Old	
	D Delete	

All records are unformatted (binary).

TABLE 1. NUDACC MASS STORAGE FILES

Data set reference No.	Routine	File type	File status	Record size (words)	Number of records
10	ENVCAL	R	NTD	100	600
11	RDEQPT	R	NTP	91	600
12	WTRER	R	NTD	75	9000
16	SURVIV	S	NTP	5	V
17	RDUNIT	S	NTD	1200	2

TABLE 2. SORT ROUTINE MASS STORAGE FILES

Data set reference No.	Routine	File type	File status	Record size (words)	Number of records
SORTIN	SORT	S	OTD	5	V
SORTOUT	SORT	S	NTP	5	V

TABLE 3. NUDPRINT PROGRAM MASS STORAGE FILES

Data set reference No.	Routine	File type	File status	Record size (words)	Number of records
1	MAIN	S	OTD	1200	2
2	MAIN	S	OTD	5	V
11	MAIN	R	OTD	91	600
12	MAIN	R	NTD	12	200

5. JOB CONTROL LANGUAGE

The run stream of listing 1 executes NUDACC, SORT, and NUDPRINT on the HDL IBM System 370 Model 168 computer. The FORTRAN IV H Extended Compiler is used.

LISTING 1. RUN STREAM TO EXECUTE NUDACC, SORT ROUTINE, AND NUDPRINT PROGRAM

```
//NUDACC JOB (Installation dependent)
//COMPUTE EXEC FORTXCG,PARM.GO='NORES'
//FORT.SYSIN DD *
               NUDACC PROGRAM
/*
//GO.FT05F001 DD *
               UNIT DATA DECK
/*
//GO.FT05F002 DD *
               WEAPON DATA DECK
/*
//GO.FT05F003 DD *
               UNIT EQUIPMENT DECK
/*
//GO.FT08F001 DD DSN=[VULNERABILITY DISK DATA SET NAME],
//    DISP=OLD
//GO.FT10F001 DD DSN=&&RDOSE,DISP=(NEW,DELETE),SPACE=(400,(600)),
//    DCB=(RECFM=F,LRECL=400),UNIT=SYSDA
//GO.FT11F001 DD DSN=&&RNCDCN,DISP=(NEW,PASS),SPACE=(364,(600)),
//    DCB=(RECFM=F,LRECL=364),UNIT=SYSDA
//GO.FT12F001 DD DSN=&&REQPT,DISP=(NEW,DELETE),SPACE=(300,(9000)),
//    DCB=(RECFM=F,LRECL=300),UNIT=SYSDA
//GO.FT16F001 DD DSN=&&SORTIN,DISP=(NEW,PASS),UNIT=SYSDA,
//    SPACE=(1084,(1000)),DCB=(RECFM=VBS,LRECL=24,BLKSIZE=1084)
//GO.F17F001 DD DSN=&&HITCNT,DISP=(NEW,PASS),UNIT=VIO,
//    SPACE=(4808,(2)),DCB=(RECFM=VS,LRECL=4804)
//SORT EXEC SORT
```

LISTING 1. RUN STREAM TO EXECUTE NUDACC, SORT ROUTINE, AND NUDPRINT PROGRAM (Cont'd)

```
//SORTIN DD DSN=&&SORTIN,DISP=(OLD,DELETE)
//SORTOUT DD DSN=&&SORTOUT,DISP=(NEW,PASS),UNIT=SYSDA
//    SPACE=(1084,(1000)),DCB=(RECFM=VBS,LRECL=24,BLKSIZE=1084)
//SYSIN DD *
 SORT FIELDS=(5.0,4.0,A,13.0,4.0,A,9.0,4.0,A),FORMAT=BI,SIZE=E10000
 END
/*
//PRINT EXEC FORTXCG
//FORT.SYSIN DD *
              NUDPRINT PROGRAM
/*
//GO.FT01F001 DD DSN=&&HITCNT,DISP=(OLD,DELETE)
//GO.FT02F001 DD DSN=&&SORTOUT,DISP=(OLD,DELETE)
//GO.FT03F001 DD *
              UNIT NAME DECK
/*
//GO.FT10F001 DD *
              EQUIPMENT NAME DECK
/*
//GO.FT11F001 DD DSN=&&PNCDCN,DISP=(OLD,DELETE)
//GO.FT12F001 DD DSN=&&MN,DISP=(NEW,DELETE),SPACE=(48,(200)),
//    DCB=(RECFM=F,LRECL=48),UNIT=VIO
//
```

6. NUDACC NAMED COMMON BLOCKS

ATTBLK

The ATTBLK block is used to pass the array AT(75,10,10) between subroutines ATTRIT, DSTRBT, RDRER, SURVIV, and WTRER (fig. 1). The array AT is used as a work area to keep track of the items of personnel and equipment surviving over the grid structure of the unit. After the number of items surviving a weapon has been calculated, the personnel items are reset at their original values due to the cumulative nature of total dose.

DKM

The DKM block is used to pass the array DKM (3,75 between subroutines ATTRIT and SURVIV. The logical array DKM is used to indicate the dominant kill mechanism for each equipment item over the unit.

DPIQ, DSBLK, EMP1, and RNF

The DPIQ, DSBLK, EMP1, and RNF blocks are used to pass the arrays DPIQ(10, 10), DOSE(10, 10), EMP1(10, 10), and RNF(10, 10), respectively, between the subroutines ATTRIT, ENVCAL, and PBSURV. The arrays respectively contain the environments ΔPI_q, total dose, vertical electric field, and neutron fluence calculated at the center of each grid square of the unit being considered.

NUMHIT

The NUMHIT block is used to pass the arrays NH(600) and IC(600) between subroutines CKUNIT, GOTONE, AND RDEQPT. The array NH contains the number of times that a unit has been within range of a weapon and reflects the fact that each personnel item generates five survival numbers. The array IC contains the total number of items associated with a unit. The NUMHIT block is eventually passed via temporary file to the NUDPRINT program.

OUTBLK

The OUTBLK block is used to arrange the value NEQP and the arrays ICODE(45) and ICOUNT(45) in contiguous areas of memory before writing to a random file. The value NEQP is the number of equipment codes associated with the unit; ICODE contains the respective equipment codes, and ICOUNT contains the number of each item of equipment represented by the code.

UNTANG

The UNTANG block is used to pass the array THETA(600) between subroutines DISSQR and RDUNIT. The array THETA contains the angle of rotation of each unit about its right rear corner.

UNTDIS

THe UNTDIS block is used to pass the array DS(10, 10) between subroutines DISSQR and ENVCAL. The array DS contains the distance from the weapon AGZ to the center of each grid square of the unit.

UNTFBL

The UNTFBL block is used to pass the array IFB(10, 10) between subroutines ATTRIT, ENVCAL, and PBSURV. The array IFB is a logical array that indicates whether a grid square is within the projection of the fireball on the ground and therefore will be destroyed.

UNTGRD

The UNTGRD block is used to pass the arrays IL(600) and IW(600) between subroutines GOTONE and RDUNIT. The arrays respectively contain the length and the width of the units in number of grid squares.

UNTHIT

The UNTHIT block is used to pass the array IH(600) between subroutines ENVCAL, GOTONE, and RDUNIT. A nonzero entry in IH indicates that the unit has been hit previously and points to the proper random record containing accumulated dose.

UNTIDN

The UNTIDN block is used to pass the array IDEN(600) between subroutines RDEQPT and RDUNIT. The array IDEN contains the respective unit identification numbers. The UNTIDN block is passed via temporary file to the NUDPRINT program.

UNTLAW

The UNTLAW block is used to pass the variables ILEN and IWID between subroutines ATTRIT, DISSQR, DSTRBT, ENVCAL, GOTONE, PBSURV, RDRER, SURVIV, and WTRER. The variables respectively contain the length and the width of the unit under consideration in number of grid squares.

UNTLOC

The UNTLOC block is used to pass the arrays XU(600) and YU(600) between subroutines CKUNIT, DISSQR, and RDUNIT. The arrays respectively contain the x and y coordinates of the units in meters.

UNTNCT

The UNTNCT block is used to pass the array NC(600) between subroutines DSTRBT, RDRER, RDUNIT, SURVIV, and WTRER. The array NC contains the number of counts associated with each unit. The individual entries reflect the fact that five counts are generated for each personnel item.

UNTNDX

THe UNTNDX block is used to pass the variables IRAN and IREC between subroutines ATTRIT, ENVCAL, GOTONE, and RDUNIT. The variable IRAN points to the next sequential random record to which dose data will be written for a unit exposed to nuclear radiation for the first time. The variable IREC points to the random record containing dose information for a unit that has been exposed previously.

UNTPER

The UNTPER block is used to pass the array NPER(600) between subroutines ATTRIT and DSTRBT. The array NPER is the total number of items of personnel information for a particular unit.

UNTRER

The UNTRER block is used to pass the array ISTRT(600) between subroutines RDRER, RDUNIT, and WTRER. The array ISTRT points to the start of the random attrited equipment records for a particular unit.

VBLK1 to VBLK10

These 10 blocks pass the arrays T2, EQNUM, IVLARY, DPMU, DPSIG, KAY, RNFMU, RNFSIG, EP1MU, and EP1SIG, respectively, between subroutines RDVULN and ATTRIT. These arrays contain the vulnerability data for each equipment item.

WEPAGZ

THE WEPAGZ block is used to pass the arrays XA(200) and YA(200) between subroutines CKUNIT and RDWEAP. The arrays XA and YA are the coordinates of the AGZ for a particular weapon.

WEPNUM

The WEPNUM block is used to pass the variable IWNM between subroutines CKUNIT and SURVIV. The variable IWNM is the sequence number of the weapon whose effects are being considered.

WEPRAD

The WEPRAD block is used to pass the arrays RN(200), RTD(200), REMP(200), and RDPIQ(200) between subroutines LARRAD and RDWEAP. The arrays respectively contain the radius beyond which the effects of neutron fluence, total dose, EMP, and ΔPI_q are insignificant for a particular weapon.

WEPYLD

The WEPYLD block is used to pass the array YIELD(200) between subroutines CKUNIT and RDWEAP. The array YIELD is the yield of a particular weapon.

7. NUDACC PROGRAM MODULES

7.1 Introduction

The computer code was designed by using the concept of functional modules. Each module resolves one of the several problems facing an analyst who wishes to know the survivability of personnel and equipment items after a weapon laydown. For example, the analyst needs to know the location of units (personnel and equipment) and the yield and the AGZ of the various weapons, to examine the magnitude of the several NWE environments produced by each weapon at each unit location. If the magnitude of any one of the environments is sufficient to damage the unit, he calculates the probability of survival of the various items within the unit due to the environment and the number of items surviving the weapon. He also records the total dose value to which any future dose from subsequent weapon burst will be added before calculating subsequent personnel survival. The NUDACC program modules perform these functions in greater detail.

7.2 *MAIN Program*

The MAIN program consists of five CALL statements to subroutines RDUNIT, RDWEAP, RDEQPT, RDVULN, and CKUNIT. The first four of these define the problem, and the fifth performs the analysis.

RDUNIT

The RDUNIT subroutine reads the location and the size of the units considered in the analysis. The number of 50-m grid squares in each unit is calculated, and several unit related arrays are set to zero.

RDWEAP

The RDWEAP subroutine reads the location and the yield of the weapons considered. The maximum radius of effect for each environment is calculated by function RMAX and stored in arrays.

RMAX

(See RDWEAP.)

RDEQPT

The RDEQPT subroutine reads the items of personnel and equipment associated with a unit and generates a random access file of equipment codes and counts for each unit.

RDVULN

The RDVULN subroutine reads the vulnerability data for each equipment item and stores the data in various arrays.

CKUNIT

The CKUNIT subroutine determines the largest of the several maximum radii of effects for a weapon with a call to subroutine LARRAD and examines each unit to see if it is in range. A unit in range results in a call to subroutine GOTONE.

7.3 *Subroutine GOTONE*

The GOTONE subroutine locates the various records required to determine the probability of survival of the unit and performs the analysis with calls to subroutines DISSQR, ENVCAL, PBSURV, and ATTRIT.

DISSQR

The DISSQR subroutine divides the unit into 50-m squares and computes the distance from the weapon AGZ to the center of each square.

ENVCAL

The ENVCAL subroutine calculates the environment at the center of each 50-m square after first determining that the square is outside the fireball radius of the weapon. If the square is inside the fireball, a status switch is set for reference during probability-of-survival calculations.

PBSURV

For the environments at the centers of each grid square in the unit, the PBSURV subroutine calculates probabilities of survival for all items in the unit that have vulnerability numbers. Function PSFUNC performs the actual calculation. These survival probabilities provide a menu from which the proper probability-of-survival numbers are chosen, depending on the unit's equipment list.

PSFUNC

(See PBSURV.)

ATTRIT

The ATTRIT subroutine calculates the number of items of personnel and equipment surviving the effects of the weapon. The items of personnel and equipment are initially evenly distributed over the unit's grid squares, that is, the first time that a unit is within range of a weapon (hit). This information is eventually written in to a random access file and read directly if the unit is subsequently hit. For items vulnerable to more than one environment, the separate probabilities of survival are multiplied, and the product is taken to be the overall probability of survival of the item.

DSTRBT

The DSTRBT subroutine distributes the original complement of the unit's personnel and equipment over the unit's grid squares. This routine is called only once: the first time a unit is hit.

RDRER

The RDRER subroutine reads the distributed items of personnel and equipment surviving before the current weapon is considered. This subroutine is called only if the unit is hit more than once.

SURVIV

The SURVIV subroutine calculates the actual number of items of personnel and equipment surviving the current weapon by taking the sum of each item over the unit's grid squares. The dominant kill mechanism also is determined.

WTRER

The WTRER subroutine writes the update random access record containing the number of each item of personnel and equipment surviving at each grid square of the unit.

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